REMARKS:

The Official Action of November 2, 2006 has been reviewed and this application has been amended as believed appropriate.

The Rejection over Ingman et al.

Claims1-12, 21-32, and 43 stand rejected as anticipated by the U.S. patent No. 6,069,804 to Ingman et al. under 35 U.S.C. § 102 (b). Paragraph 2 of the Official Action indicates what parts of the Ingman et al. patent are considered to disclose the features of at least some of the rejected claims. Ingman et al relates to a DC-DC converter of a kind referred to in this application's Background of the Invention in which an optical coupler is used to communicate between the secondary circuit and the primary circuit to control the converter's duty cycle and thus provides self regulation. Column 12, lines 11 to 42 do support the conclusion that the Ingman patent teaches switching on the primary and secondary switches at zero voltage and a slight reverse current as claimed in a number of claims of the present application. Also Ingman et al. teach comparing output voltage with a reference voltage at a reference circuit 140. However, the monitoring of the output voltage is not used to control the secondary switch as in the invention, but is sent to the primary circuit to control the primary switch using a pulse width modulator 190.

The rejection is incorrect as to claim1 (and claims 2-10, by their dependency), it is respectfully urged, because that claim calls for a current sensor in at least one of first and second control circuits controlling first and second semiconductor switches "for detecting the direction of current through the semiconductor switch controlled by that control circuit and enabling the turning ON of that semiconductor switch when a reverse current through the switch is detected." The outstanding Official Action cites column 4, lines 40 - 45 of Ingman et al. for the use of current sensors. The Ingman et al. patent does not refer to a current sensor at column 4, lines 40 - 45, but only to manner of operation of the Ingman et al. DC-DC converter. The Ingman et al. patent states:

> Applicants have discovered, however, that if the reverse flow of current is properly controlled and recirculated it can improve the operation of single and multiple-output flyback converters. Improvements are made possible in operating efficiency, cross regulation, high line no load stability,

> and in load transient response. Battery backup operation is more easily accomplished.

See Ingman, Col. 4, lines 40 - 46. Ingman et al. do not have a current detector to detect a reverse current through a semiconductor switch to enable turning on of that switch. Additionally, the Official Action refers to the winding 124 of Fig. 9 of Ingman et al. as a "controlled winding." It is not clear, but it is believed that the Official Action is referring to a "control winding" such as is called for in, for example, claim 9. However, winding 124 of Ingman et al. Fig. 9 is not a control winding but one of two "output" windings of the transformer 60. See Col. 10, line 44 and Col. 11, lines 6 - 9. This is because the DC-DC converter of Ingman et al. Fig. 9 is a multiple output converter. See Col. 9, lines 39 - 42. Withdrawal of the rejection of claims 1 - 10 as anticipated by Ingman et al. is respectfully requested.

As applied to claim 11 and dependent claim 12 the rejection over Ingman et al. is similarly defective. Independent claim 11 calls for:

(c) means for sensing current in one of the first and second semiconductor switches, and

(d) one of the control means being connected with the means for sensing and adapted to turn ON the semiconductor switch at substantially zero voltage across the switch and reverse current through the switch as sensed by the means for sensing.

From this it is clear that the "one of the control means" uses the sensing of current in the one semiconductor switch and turns ON that switch when the current is reversed. As pointed out above, the converter of the Ingman et al. patent does not operate thus. It does not sense current in one of its switching transistors to turn ON that switching transistor and that is not made obvious by the art of record. Claim 11 and its dependent claim 12 are not anticipated or suggested by the Ingman et al. patent. Withdrawal of the rejection over Ingman et al. and allowance of claims 11 and 12 are respectfully requested.

Claim 21has been amended to make it clear that the turning on of a semiconductor switch is enabled in response to one or more parameters sensed in the circuit into which that semiconductor switch is connected. Again, this distinguishes claim 21 from the converter of the Ingman et al. patent in which the comparison of output voltage, in the secondary circuit, to a reference voltage is used in the control of the primary circuit not the secondary circuit where the

output voltage occurs. As amended, claim 21 patentably differs from the Ingman et al. patent and it and dependent claims 22 - 32 should not be allowed.

Independent method claim 43 also differs patentably from the Ingman et al. patent in that it calls for turning ON the second semiconductor switch when the output voltage generated in the second circuit that includes the second semiconductor switch bears a predetermined relationship to a reference voltage. As pointed out above the Ingman et al. converter uses its voltage comparison in the secondary circuit in the control of the semiconductor switch in the primary circuit. The rejection of claim 43 should now be withdrawn it is respectfully urged and this claim should be allowed.

The Rejection over Faulk

Claims 13 to 20 are rejected in the outstanding Official Action as anticipated by the U.S. patent No. 5,841,641 to Faulk. The Faulk patent teaches a DC-DC converter having semiconductor switches connected to primary and secondary windings and control circuits for each of the semiconductor switches. As in the converter of the present invention, the primary circuit's semiconductor switch is controlled to allow the current in the primary to go negative before the switch is turned OFF with zero voltage across the switch. The Faulk patent does teach monitoring the current in the primary circuit for the purpose of determining when to turn OFF the primary semiconductor switch. The Faulk patent also teaches monitoring the voltage across the secondary winding of the power transformer as a way of determining when to turn ON the secondary semiconductor switch. Comparing a developed voltage that is related to the output voltage to a reference voltage is taught. The timing of the switching of the semiconductor switches, primary and secondary winding currents and the voltage on the drain of the primary semiconductor switch are plotted in Fig. 2 of the patent.

The purpose of Faulk's allowing the secondary current to go negative is to discharge a capacitor (114 in Fig. 1) across the primary semiconductor switch before turning on that switch. See Col. 4, lines 63 - 65. The Faulk patent does not address transferring energy back into the primary circuit as a way of controlling the duty cycle and thus regulating the output voltage of the converter. Independent claim 13 expressly states that "a reverse current level" is induced in the primary winding "to thereby cause, when the secondary circuit voltage sensing control circuit senses an over-voltage condition, energy to be transferred back to the primary winding circuit

from the secondary winding circuit at a level depending on the level of over-voltage." This does not occur in Faulk. The transfer of energy back to the primary circuit in the Faulk patent is not dependent on the sensing of any over voltage. Faulk discloses two embodiments of a DC-DC converter. The first embodiment has independent controllers for the switching transistors 110 and 116 in the primary and secondary circuits. At column 7, lines 16 to 30, Faulk discloses two alternative ways to determine when to turn OFF the switching transistor 116 in the secondary circuit so that the capacitor 114 in the primary circuit is sufficiently discharged. One way is to wait a fixed time after the current I_s in the secondary circuit has gone negative. Col. 7, lines 23 - 27. Alternatively, I_s is measured and transistor 116 is switched off when I_s has reached a "sufficient negative amplitude." Col. 7, lines 28 - 30. Neither alternative provides switching OFF the transistor as a function of a measured over-voltage. This would not be obvious from Faulk since Faulk's only purpose in sending energy back into the primary is to assure discharge of the capacitor 114 across the primary transistor switch. Faulk states, at Col. 4, lines 42 - 49:

> Inductor 104, diode 120, and capacitor 118 constitute the necessary components to form an output circuit of a typical flyback switched mode power supply; however, in this reciprocating energy flyback switched mode power supply, transistor 116 enables the output circuit 108 to supply energy back to the input circuit 106, thereby allowing the discharge of the drain-source capacitor 114 of transistor 110.

Concerning Faulk's second and preferred embodiment, the controllers for the transistors 110 and 116 are not independent. The controller 144 in the secondary circuit is a master controller and the controller 142 in the primary circuit is a slave controller. The timing of the turning OFF of the transistor switch 116 is explained at column 14, lines 13 - 43. The on-time of the transistor is not dependent on the converter's output voltage but is based on a fixed delay and a delay "governed by the ISNS input." There is, again, no mention of varying the turn-off time of the transistor 116 in dependence on any degree of output over-voltage. Again it should be noted that Faulk only seeks to assure that the capacitor 114 is discharged before the primary transistor switch is switched ON.

Regarding the citation to column 30, line 35 of Faulk in the Official Action in relation "self-regulation." The regulation referred to by Faulk is regulation of the voltage V_{cc} used in the control circuits and not self-regulation of the converter and its output voltage. As for "over-voltage and zero crossing" referred to and citing Faulk at column 25, lines 1 - 65, again any

"over-voltage" referred to is in the voltage V_{cc} not V_{out}. The cited sections of the Faulk patent do not support the rejection of claim 13 (and dependent claims 14 - 20) as anticipated or suggested by the Faulk patent and it is requested that this rejection be withdrawn. It is urged, then, that the rejection of claim 13 and the dependent claims 14 - 20 as anticipated by the Faulk patent is in error. Withdrawal of this rejection is respectfully requested.

The Rejections over Taurand

Claims 33 to 42 stand rejected as anticipated by the U.S. patent No. 5,745,351 to Taurand. For the Taurand patent to anticipate the invention of claims 33-42, the patent would need to teach every feature of these claims.

Among other teachings, the Taurand patent relates to a DC-DC converter with control circuits for switches in the primary and the secondary circuits. The examiner relies primarily on Fig. 10 for his contention that the control of the primary and secondary switches of Taurand is the same as claimed in claims 33-42.

With regard to claims 33, it is respectfully urged that the rejection is in error. Claim 33 most significantly calls for a control circuit controlling a switch in the secondary based on the comparison of a converter's output voltage and a reference voltage. In the Taurand patent in Fig. 10, an output voltage is, in fact, compared to a reference voltage V_{ref}, but this comparison is not used to control the switch in the secondary. Rather it is used by a control circuit 80 to decide when to send a signal S(T4) to the primary control circuit 70 telling the primary control circuit to turn on the switch in the primary circuit. Hence, the DC-DC converter of claim 33 is not anticipated or made obvious by the Taurand patent. It is requested that the rejection of claim 33 be withdrawn.

Claim 34 is a method claim rejected as anticipated by the patent to Taurand. Claim 34 has been amended to provide for first and second control circuits that turn ON and OFF first and second semiconductor switches solely on the basis of operating parameters in the first circuit in the case of the first transistor switch, and solely on the basis of operating parameter in the second circuit in the case of the second semiconductor switch. This differs from Taurand. In Taurand it can be seen that control of the switch T_P by the control 70 in the primary circuit depends on $G\varepsilon$ derived from the output voltage V_{out} of the secondary circuit as compared to V_{ref} by the comparator 61. See Col. 12, lines 4 - 7 of Taurand. Also in Taurand control of the switch T_g in

the secondary circuit depends on a signal S (T_2') sent to secondary switch control 80 from primary switch T_S control 70. See Col. 12, lines 12 - 16 of Taurand. It is respectfully urged that, as amended, claim 34 differs very significantly and patentably from Taurand and should now be allowed.

Claim 35 is dependent from claim 34 and patentable over Taurand by its dependency. Additionally, claim 35 calls for "coupling first and second current sensors in current sensing relation with the first and second circuits, respectively, and inputting first and second current direction signals to the first and second semiconductor switches, respectively." Taurand does not do this and so does not anticipate claim 35 on this basis as well. Allowance of claim 35 is respectfully requested at this time.

Independent claim 36 has been amended to clarify that the step of detecting when there is a reverse current in the secondary semiconductor switch is "by current sensing means in the second circuit." The Taurand patent converter does not do this. Taurand's secondary does not have a current sensor. With this it is believed that claim 36 (and by their dependencies claims 37 - 41) patentably differ from Taurand. Allowance of claims 36 - 41 at this time is respectfully requested.

Conclusion

For each of the foregoing reasons it is believed that all of the claims now present in this application are presently allowable over the art of record and favorable reconsideration to that end is respectfully requested.

A three month extension of time in which to respond to the outstanding Official Action is requested in the accompanying Request for Extension, submitted in duplicate. A check in the amount of $1,020.00 is enclosed to cover the fee for a three month extension. No further fee is believed necessary, however the Commissioner is authorized to charge any insufficiency or credit any overpayment to the deposit account number 070135 of attorneys for applicant.

Should the examiner have questions, comments or suggestions regarding this application, the examiner is invited to please contact the undersigned at the telephone number of email address listed below.

Respectfully submitted,

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